Amendments to the Drawings:

The attached sheets of drawings include changes to FIG. 2, as well as formal versions of FIGS. 1-9 (see Exhibit A). These sheets, which include FIGS. 1-9, replace the original sheets including FIGS. 1-9.

Attachment: Replacement Sheets (Exhibit A)

REMARKS/ARGUMENTS

Upon review of the application, it appears that Fig. 2 was never submitted in the application. It also appears that no description of Fig. 2 was included in the specification as filed. Accordingly, Applicants have inserted FIG.2 as well as a description thereof, taken from the description of FIG. 2A in U.S. Provisional Application No. 60/125,462, from which the present application claims priority. The description of the figure can be found from the last paragraph on page 9 of the provisional through the first paragraph on page 10. A copy of this provisional was previously filed as Exhibit A with the response filed on June 9, 2003. Copies of the relevant pages and the figure also are attached hereto as Exhibit B. As matter in the added figure and language was contained in the provisional, which was incorporated into the present application by reference, it is respectfully submitted that the new language and figure do not add new matter to the specification.

The amendments to the specification also update the status of issued U.S. Utility Patent No. 6,690,473.

It should also be noted that the newly submitted FIG. 2 includes the correction of an inadvertent typographical error relating to reference 237 in the provisional application, which would be obvious in light of the specification. The attached figures also present formal versions of FIGS. 1-9. The changes to the figure are supported by the provisional application, and not intended to alter the scope of the invention or be interpreted as a limitation on the claimed invention.

Consideration of the amendments proposed herein is respectfully requested.

The Commissioner is hereby authorized to charge any deficiency in the fees filed, asserted to be filed, or which should have been filed herewith (or with any paper hereafter filed in this application by this firm) to our Deposit Account No. 50-1703, under Order No. TWI-30200.

Respectfully submitted,

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may be arbitrary. For example, the embodiment of FIG. 1 could be operated on its side or upside down. While redesign some of optics might be preferred in such cases, it would not be necessary.

As one skilled in the art will recognize, the use of reflective optics in embodiments of the present invention may have advantages. There are at least three advantages of reflective optics. Fresnel reflections occur at the surfaces of refractive optics (ie lenses) and may be a source of systematic noise in the system. For example, light that has suffered a Fresnel reflection at an objective lens can arrive at the detector even if there is no wafer present. Thus, this light has no information about the wafer and is noise. In contrast, reflective optics generally do not suffer from Fresnel reflections. Refractive optics also can limit the bandwidth of the light that passes through them in two ways. Preferred embodiments with refractive optics use anti-reflective coatings (ARC) to minimize Fresnel reflections. Typically, ARC's are resonant structures that operate well over a limited spectrum of wavelengths. Outside of that range, their transmission is reduced, potentially limiting the bandwidth of the system. Also, the index of refraction of most materials is a complex function of wavelength. The imaginary part of the refractive index (K) describes attenuation of light at a particular wavelength as it propagates through the material. Thus, many lens materials can restrict the bandwidth of the system by having a large K at wavelengths within the desired spectrum. The second advantage of reflective optics is that they avoid attenuation of light as it propagates through lens materials. The third problem with refractive optics, which must be addressed is color correction. The real part of the refractive index, N, is also a function of wavelength. N affects, for example, the focal length of lenses. Therefore, lenses have chromatic aberration such that different colors focus at different depths. This is commonly 'corrected' by using materials with different spectral N for various components in the system. Since reflective optics do no use refraction to focus, they do not suffer from chromatic aberration do to the spectral changes in refractive index N.

Reflective optics, however, have certain constraints on aperture and geometry which make the refractive optics a preferred in certain embodiments. In these embodiments, optics are color-corrected for the semiconductor wafer immersed in water. The design of the optics considers the water as an optical component.

In the embodiment shown in FIG. 1, the optical measurements are made through window 120, which is fixed relative to the laboratory. Alternate embodiments than that shown in FIG. 1 utilize a novel window embodiment. FIG. 2A illustrates a prior art device with a single large window fixed relative to the laboratory. In FIG. 2A, wafer 200, water

surface 201, containment wall 203, objective lens assembly 207, beam splitter 235, relay optic 237, and window 202 are shown. It is noteworthy that this prior art device utilizes a single large window 202. For accurate measurements, window 202 must be of optical quality. Due to the size of the window, this can lead to considerable expense.

FIG. 2B shows a novel approach according to aspects of this invention. In FIG. 2B, wafer 200, column 201, small scanning window 202, detector optics 203, beam splitter 235, mirror 237, optical fiber 204, optical assembly 205, illumination optics 206, and objective lens assembly 207 are shown.

In FIG. 2B, a portion of the optical system is a column of water fixed relative to the objective lens assembly 207. The floor of column 201 is a small window 202. Column sides 209 rise to leave only a small gap between themselves and the wafer. Water flows into the column from supply line 206. A combination of surface tension and viscosity hold the water in place. Depending on the gap height, water may need to be flowing continuously to maintain a continuous column between the wafer 200 and small window 202. Additional jets may be used to remove bubbles. It is noteworthy in the above that the water column forms an optical element. Particular embodiments may comprise an extended water trough.

Referring to FIG. 2B, the watertight, scanning optical assembly 205 has illumination optics 206, which receive light from optical fiber 204. The illumination optics transmit a beam of light (which may or may not be collimated) through beam splitter 235 to objective lens assembly 207. Objective lens assembly 207 focuses the beam onto the wafer and collects the reflected light and sends it to mirror 237 as a (collimated or uncollimated) beam. The mirror deflects the light reflected from wafer 200 into the detector optics 203, which comprises a pinhole spectrometer and a vision system employing pattern recognition (not shown) to allow for precise positioning of the optical assembly 205 to pre-taught locations on the wafer. Mechanical translation stages (not shown) scan the entire assembly 205 with its water column and optics.

This aspect of the present invention has two advantages in comparison to utilization of a single large window and water bath. First, the objective always looks through the same portion of the window, so that its quality does little to affect the quality of the measurement. (Its effects can be removed by calibration). Second, because it is smaller than windows used in the prior art, it is much easier to obtain a very high-quality surface finish.

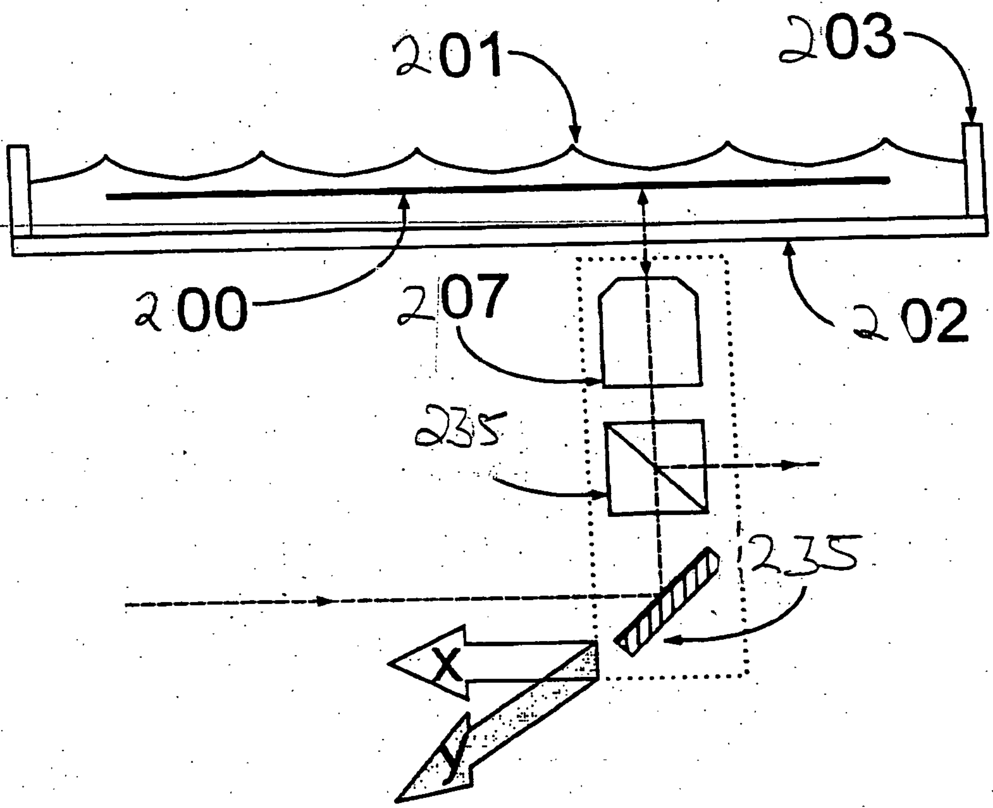

Figure 2A (Prior art)